ELECTROMAGNETIC MODELING OF DISTRIBUTED-SOURCE-EXCITATION OF COPLANAR WAVEGUIDES: APPLICATIONS TO TRAVELING-WAVE PHOTOMIXERS

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Abstract

An electromagnetic model is presented for the characterization of a distributed source excitation in coplanar waveguides (CPW). The solution to this problem is directly applicable to the understanding and optimization of membrane traveling-wave photomixers[1]. This local oscillator technology is capable of generating radiation above 1 THz and may make the implementation of future wide-band electronically tunable heterodyne receivers possible. The methodology we present allows the determination of the intrinsic dynamic propagation constant along the CPW, the optimal lengths of the active area needed to generate the maximum RF power, and an evaluation of the amount of radiated power when matching to a slot antenna.

The analysis is performed in two steps: First, the magnetic current distribution is evaluated in the two gaps of an infinitely extended CPW excited by a distributed impressed electric current. We achieve this by assuming that the dependence of the magnetic currents are separable in the transverse and longitudinal dimensions. The transverse dependence is well represented by one-edge-singular basis functions. These basis functions have opposite signs in the two slots to represent the propagating asymmetric mode. The longitudinal magnetic current distribution is obtained by superposing the solutions of plane wave scattering problems. Each of these plane waves arises from the longitudinal expansion of the impressed magnetic field, which is distributed over a finite area. In the second step, a slot antenna that is matched to the CPW line is introduced, to launch the maximum possible power into free-space. We validated the procedure described in step one and the behavior of the entire structure, CPW and slot antenna, with a custom-developed Galerkin Method-of-Moments code. To our knowledge, this is the first attempt to model a distributed electromagnetic source in this manner.

[1]S. Matsuura, G.A. Blake, R.A. Wyss, J.C. Pearson, C. Kadow, A.W. Jackson, and A.C. Gossard, "A traveling-wave THz photomixer based on angle-tuned phase matching", *Appl. Phys. Lett.* **74**, 2872 (1999).